

# 16K Ram Board

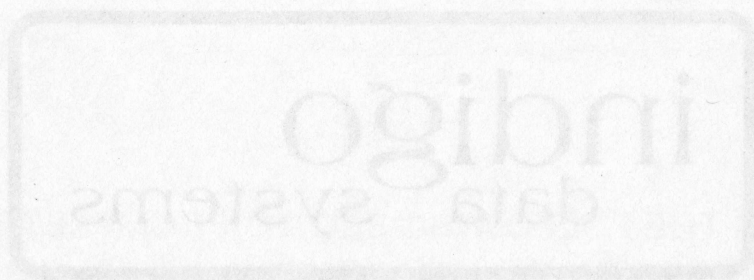
INSTALLATION AND OPERATION MANUAL

indigo  
data systems

PRELIMINARY

# 16K Ram Board

INSTALLATION AND OPERATION MANUAL



# INTRODUCTION

Indigo Data Systems' 16K Ram Board will expand the memory capacity of a 48K Apple II or Apple II Plus to a full 64K bytes of random access memory (RAM). The 16K Ram Board is logically compatible with the Language Card (excluding the Autostart ROM). All software which will run on the Language Card will run on the 16K Ram Board. This includes software designed to run with the Microsoft Z-80 SoftCard.

The following is a partial list of languages and software known to require or take advantage of the extra memory gained with the 16K Ram Board:

DOS 3.3 (Integer and Applesoft BASICs)

FORTRAN

Pascal

VisiCalc

LISA 2.0

CP/M

Microsoft BASIC

The ambitious programmer may add additional 16K Ram Boards to expand memory in increments of 16K bytes. Special daisy chain control circuitry unique to the Indigo Data Systems 16K Ram Board may be used to prevent accidental access of more than one board at a time.

Indigo Data Systems' 16K Ram Board was designed with performance and reliability in mind and has been constructed of high quality material and components. Power consumption has been kept to a minimum to keep your computer running cool. Each board has been fully burned in and tested to insure many years of reliable service.

Apple II, Apple II Plus, Applesoft, and Language Card are trademarks of Apple Computer Inc.

SoftCard is a trademark of Microsoft, Inc.

CP/M is a trademark of Digital Research, Inc.

VisiCalc is a trademark of Personal Software, Inc.

LISA 2.0 is a product of Programma International, Inc.

**READ THE FOLLOWING SECTION COMPLETELY  
BEFORE INSTALLING THE 16K Ram Board.**

## INSTALLATION IN SLOT 0

Installation of the 16K Ram Board is a simple procedure; however, to protect your new board as well as your computer, certain precautions should be taken. The dynamic RAM chips on the board are susceptible to damage by static electricity such as is generated by walking on carpet. Therefore it is wise to handle the board only when necessary and then only by the edges.

Prior to installing the 16K Ram Board in slot 0, the RAM chip on the Apple motherboard closest to slot 0 must be removed and installed in the empty socket on the 16K Ram Board. The plug from the 16K Ram Board must then be inserted in the resulting empty RAM socket on the Apple motherboard. If this procedure is unfamiliar to you, carefully read the detailed instructions which follow before installing the board. If you are uneasy about installing the board yourself, don't hesitate to ask your dealer for help as incorrect installation can result in damage to both the 16K Ram Board and your Apple.

1. **TURN OFF YOUR COMPUTER!** Installing a board with the power on can be disastrous.
2. Remove the cover of your Apple by lifting on the two back corners to pop it loose. Slide the cover backwards to free it.
3. Touch the Apple's power supply with each hand to release any static charge that you may be carrying. The power supply is the long metallic box along the left side of the computer.
4. Facing the computer from the front, locate the 3 rows of RAM chips outlined in white on the Apple's main circuit board. Using an IC extraction tool or a small flat bladed screwdriver, carefully remove the RAM chip in the rear left hand corner. Do not try to pry the chip loose with your fingers as this usually results in bent pins on the chip and holes in your thumb. If a small screwdriver is used, be very careful not to bend any of the pins on the RAM chip. Insert this chip into the empty socket on the 16K Ram Board taking care that each pin fits a hole in the socket and does not bend. The chip should face the same direction as the other RAM chips on the board (note the small dot or indentation on one corner of the chip).
5. Locate slot 0 on the Apple circuit board. This is the leftmost of the 8 peripheral connectors which are located along the back of the Apple motherboard. The card edge connector on the 16K Ram Board will be inserted into this socket. (The card edge connector is the wide protrusion with 25 gold tabs on each side). With one hand, hold the 16K Ram Board over slot 0 as if to insert it. With the other hand, fold the ribbon cable so that the plug on the end faces down. Do not twist the cable. Carefully insert this plug into the empty RAM socket on the Apple motherboard.



6. Now insert the 16K Ram Board fully into slot 0. Make sure that it is seated properly.

Before replacing the Apple's cover, double check that the RAM chip and plug are installed correctly. The ribbon cable should be such that the side towards the front on the 16K Ram Board is also towards the front on the Apple motherboard.

You may have noticed 5 small connector pins on the 16K Ram Board as you were installing it. The function of the two pins labeled O and I will be described later in this document. The pins labeled X,Y, and Z are for future enhancements by Indigo Data Systems.

## OPERATION

After double checking the card installation, turn the computer on. If it behaves strangely or does nothing at all, turn the power off and check the installation again or consult your dealer.

The 16K Ram Board is now ready for use and in most cases will require no further action on your part. Refer to the documentation supplied with your software packages (DOS 3.3, VisiCalc, LISA 2.0, etc.) to learn how they make use of the extra memory.

If you are running under DOS 3.2.1 or an earlier version, you should purchase the Apple DOS 3.3 Upgrade Kit from your dealer in order to take full advantage of the 16K Ram Board. Under DOS 3.3 both Integer BASIC and Applesoft BASIC will be available automatically. If you own a standard Apple II, Integer BASIC resides in the Apple's Read Only Memory (ROM) and Applesoft BASIC will be loaded from diskette into the 16K Ram Board. If you own an Apple II Plus, Applesoft BASIC resides in the Apple's ROM and Integer BASIC will be loaded from diskette into the 16K Ram Board. In addition, the DOS 3.3 Upgrade Kit includes the new disk controller PROMs required for the higher density 16 sector diskettes.

If you own an Apple II Plus, the Autostart ROM system monitor program will be used with both versions of BASIC and your system diskette will be automatically booted when the power is turned on. (The monitor program will actually be located in RAM for Integer BASIC). If you own a standard Apple II, the Autostart ROM monitor (in RAM) is used with Applesoft BASIC and the old Monitor ROM is used with Integer BASIC. When a standard Apple II is turned on, the system diskette must be booted manually as usual. Assembly language programmers may prefer to have the old Monitor ROM available in order to take advantage of the STEP and TRACE debugging tools which were eliminated from the Autostart ROM. If not, owners of standard Apple II's may purchase the Autostart ROM chip from an Apple dealer.

# SOFTWARE CONTROL OF THE 16K RAM BOARD

The 16K Ram Board operates in the same memory space normally occupied by the Apple's Read Only Memory. Software controlled switches are used to enable data reads from the 16K Ram Board while disabling the Apple's ROM and vice versa. Also, the 16K Ram Board may be write protected and write enabled under software control.

The 16K Ram Board occupies the memory space from \$D000 to \$FFFF. Since this is only a 12K range, the lower 8K bytes are bank selected under software control into the 4K range from \$D000 to \$DFFF. This is necessary because the Apple's memory from \$C000 to \$CFFF is reserved for input/output and peripheral card ROM space. The upper 8K bytes of the 16K Ram Board occupy memory from \$E000 to \$FFFF without bank selection.

Control of the above features is accomplished by performing read operations (LDA in assembly language) on addresses in the range \$C080 to \$C0BF. Bit 0 (least significant) of the address controls the RAM write protect function. The EXCLUSIVE-OR of bits 0 and 1 controls RAM or ROM read selection. Bit 3 controls bank selection. The following table specifies the function of each address shown in both hexadecimal (indicated by \$) and decimal (a negative number for BASIC PEEKing). The addresses in parentheses may also be used since bit 2 is unused for selection.

Bank Select for \$D000-\$DFFF		
Bank 2	Bank 1	
\$C080(or \$C084) -16256(or -16252)	\$C088(or \$C08C) -16248(or -16244)	RAM read enable. Write Protect.
\$C081(or \$C085) -16255(or -16251)	\$C089(or \$C08D) -16247(or -16243)	RAM read disable. Write enable. (Two reads required)
\$C082(or \$C086) -16254(or -16250)	\$C08A(or \$C08E) -16246(or -16242)	RAM read disable. Write protect.
\$C083(or \$C087) -16253(or -16249)	\$C08B(or \$C08F) -16245(or -16241)	RAM read enable. Write enable. (Two reads required)

When RAM read is enabled, the Apple's on-board ROM from \$D000 to \$FFFF is disabled. When RAM read is disabled, the ROM is enabled (including the F8 system monitor ROM which is permanently disabled by the Language Card). Note that to write enable the 16K Ram Board, two successive reads are required to the addresses indicated. Also, the board may be write enabled even though the Apple's ROM is enabled.

When the computer is turned on, the 16K Ram Board is initialized to RAM read disabled, write enabled, and bank 2 selected. Pressing the RESET key does not affect the condition of the 16K Ram Board.

## ADDITIONAL 16K RAM BOARDS

Additional 16K Ram Boards may be installed in your Apple to further expand its memory in 16K increments. Although current packaged software does not support this additional RAM, programmers will find the extra memory a good place to put assembly language routines to be called from BASIC or some other high level language in order to maximize the memory available to the main program.

Three 16K Ram Boards may be installed without exceeding Apple's power supply specifications for the peripheral cards.

The additional 16K Ram Boards may be installed in any of slots 1 through 5 (6 & 7 will not allow the ribbon cable to reach a RAM socket). Follow the instructions for installation in slot 0; however, insert the ribbon cable plug into a RAM socket on the main board just to the right of the installed 16K Ram Board (Any of the back row of RAM sockets will do, however the ribbon cable must reach without stress).

To eliminate the possibility of enabling reads from more than one 16K Ram Board simultaneously (which may shorten the life of your board), the boards should be daisy chained. Near the middle of each board at the top there are two pins labeled O and I for Output and Input. To daisy chain the boards, connect the O pin of one board to the I pin of the next with a jumper wire (Supplied by Indigo Data Systems upon request for a minimal charge). The card with the O pin connected will have read priority over the card whose I pin it is connected to (i.e., if both cards are read enabled, only the card with priority will send data to the microprocessor). The write enable function is not affected by the daisy chain. Thus it is possible to write to more than one board at a time.

The control addresses of the additional 16K Ram Boards must be translated to the range indicated in the following table.

Slot #	Control Address Range
1	\$C090-\$C09F
2	\$C0A0-\$C0AF
3	\$C0B0-\$C0BF
4	\$C0C0-\$C0CF
5	\$C0D0-\$C0DF

## POWER SUPPLY CURRENT REQUIREMENTS

Supply	16K Ram Board Typical	Maximum available to all peripheral boards*
+5V	50mA	500mA
+12V	65mA	250mA
-5V	0.4mA	200mA

\*as specified in the Apple II Reference Manual.

## 90 DAY LIMITED WARRANTY

Indigo Data Systems warranties the 16K Ram Board against defects in material and workmanship for a period of 90 days from the date of purchase. Any board proving to be defective during the 90 day warranty period will be repaired or replaced provided it is returned prepaid to Indigo Data Systems within the warranty period. No other warranty is expressed or implied. This warranty does not apply to boards which have been subjected to electrical or physical abuse. Indigo Data Systems assumes no liability for incidental or consequential damages resulting from any use or misuse of this product or manual.

Out-of-warranty repair service is available from Indigo Data Systems for a nominal service charge. Shipping must be prepaid and the repaired board will be returned C.O.D.

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